

PRESENTACIÓN MURAL

Bibliographic compilation of NIR spectroscopy for stars in the Galactic O-Star Catalog

Simón Torres Robledo¹, Rodolfo Barbá^{1,2}, Julia Arias¹, & Nidia Morrell³

¹ *Departamento de Física, Universidad de La Serena, Av. Cisternas 1200 Norte, La Serena, Chile*

² *Instituto de Ciencias Astronómicas, de la Tierra y del Espacio, CONICET, Casilla 467, 5400 San Juan, Argentina*

³ *Las Campanas Observatory, Observatories of the Carnegie Institution of Washington, La Serena, Chile*

Abstract. We are carrying out a bibliographic compilation of near-infrared (NIR) ($0.7 - 5.0 \mu\text{m}$) spectroscopic studies available for stars in the Galactic O Star Catalog (GOSC, Maíz Apellániz et al. 2004). This compilation allows us to quantify the precise degree of knowledge about NIR spectral information for GOSC sources, such as band coverage, spectral resolution, equivalent-width measurements, etc. This bibliographic compilation has a clear next step toward the development of a new catalog of O-type stars observed only in the NIR, which will be annexed to the GOSC. In this poster paper we present preliminary results derived from a set of different attributes extracted from the retrieved papers.

Resumen. Estamos llevando a cabo una recopilación bibliográfica de los estudios espectroscópicos en el cercano infrarrojo ($0.7 - 5.0 \mu\text{m}$) disponibles para las estrellas del Catálogo de Estrellas O Galácticas (GOSC, Maíz Apellániz et al. 2004). Esta recopilación nos permite cuantificar de forma precisa el grado de conocimiento acerca de la información espectral en el cercano infrarrojo para las estrellas del GOSC, tales como banda de cobertura, resolución espectral, medidas de anchos equivalentes, etc. Este proyecto tiene un próximo paso definido que es el desarrollo de un nuevo catálogo de estrellas de tipo O observadas sólo en el cercano infrarrojo, el cual será anexado al GOSC. En este trabajo presentamos resultados preliminares de un conjunto de atributos extraídos de las publicaciones recolectadas.

1. Motivation

There are many open questions about the spiral structure and stellar distribution in the Milky Way (MW). While the structure outlined by star forming regions (SFR) and molecular clouds is relatively well known, it is difficult to be drawn using only massive stars and young open clusters. In spite of the progress made, the spiral structure beyond 2 kpc from the Sun, as well as that on the

far side of the Galaxy, is poorly determined. Lépine et al. (2011) show how dramatic is this situation. Their Figures 7 and 9 plot the distribution of CS and maser sources (tracers of SFRs) in the Galactic Plane, in contrast with stellar optical/NIR tracers like Cepheids and young open clusters. Comparing these two distributions, we can infer that about 90% of the spiral structure as traced by the youngest stellar populations is still completely unknown.

On the other hand, the knowledge of the number and distribution of massive stars is intrinsically important because these stars play a crucial role in the dynamic and chemical evolution of the MW.

Modern deep NIR sky surveys (e.g. VVV, Minniti et al. 2010; UKIDSS, Hewett et al. 2006) are opening a new window of galactic explorations. We now have the opportunity to discover an abundant population of hidden massive stars from the stellar candidates selected from those surveys. Thus, NIR spectroscopy, through spectral classification, is an indispensable tool allowing us to determine the nature of these candidates.

At present, the primary source of knowledge about massive stars (with 99% completeness at $B < 8$), is the *Galactic O Star Catalog* (GOSC, Maíz Apellániz et al. 2004). The GOSC collects information for the optically brightest galactic O-type stars (370 objects), providing coordinates, spectral types, optical and near-infrared photometry, and other useful information. Sota et al. (2008) presented the second version of GOSC, which seeks to extend the catalog to $B < 14$. Moreover, we are part of the *Galactic O-Stars Spectroscopic Survey* (GOSSS, Maíz Apellániz et al. 2011), this all-sky intermediate-resolution spectroscopic optical survey of all O-type stars, is designed to revolutionize the spectral classification system through high-quality and homogeneous spectroscopic observations of more than one thousand O-type stars. Based on GOSSS data, Sota et al. (2011) re-discussed the spectral classification system and presented a new atlas of O Stars.

In the NIR regime, the general spectroscopic classification system for O-type stars is based on a few atlases (e.g. Hanson et al. 1996, 2005). These atlases constitute the tool to perform a Morgan-Keenan (MK) process of spectral classification in the NIR regime in a similar way as in the optical. Unfortunately, the quality and incompleteness of the published NIR spectroscopic atlases is not enough to reproduce the MK system in this regime, and many ambiguities are detected.

We are planning a new NIR spectroscopic survey in order to establish the basis of a spectroscopic classification system for O-type stars in NIR comparable in quality and number of standards to that performed in the optical by Sota et al. (2011). As a first step, we are now retrieving bibliographic spectroscopic resources for the GOSC sources in the NIR domain, which allow us to quantify the precise degree of knowledge about NIR spectral information for GOSC entries, like band coverage, spectral resolution, equivalent-width measurements, etc. This bibliographic compilation has a clear next step toward the development of a new catalog of O-type stars observed only in the NIR (GOSC-IR), which will be annexed to the GOSC.

In this poster paper we present preliminary results derived from a set of different attributes extracted from the retrieved papers.

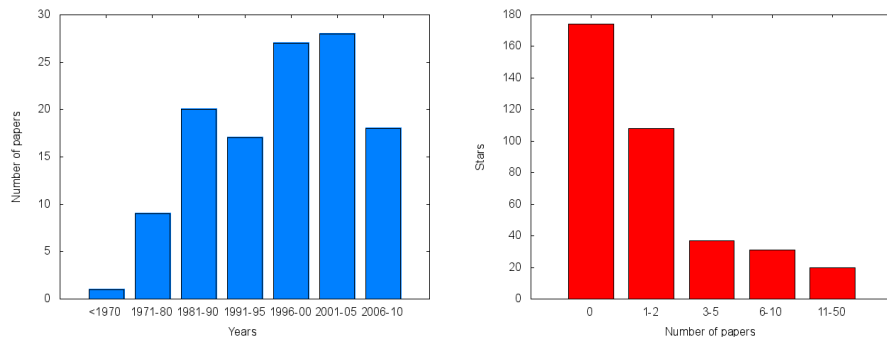


Figure 1. *Left:* Distribution of the number of published papers with NIR spectroscopy for O-type stars by year interval. The first published paper showing an *I*-band photographic spectrum of an O-type star corresponds to *Spectre infrarouges de quelques étoiles des premiers types entre 6500 et 8800 Å* by Andrillat & Houziaux (1967). *Right:* Distribution of the number of O-type stars by number of papers. Note that almost 50% of GOSC sources have no published NIR spectroscopic information.

2. The bibliographic catalog

We retrieved the spectroscopic bibliographic information for 370 GOSCv1 sources using the NASA *Astronomical Data System* (ADS). We deployed different strategies to find papers which contain spectroscopic observations (from X-rays to IR) of GOSC entries. The total number of bibliographic entries counted is 28229 (including part of year 2010), from which 837 entries are related to NIR spectroscopy for 196 stars (Figure 1). These entries correspond to 123 independent papers. The first obvious result is that almost 50% of the GOSC stars have not published spectroscopic observation beyond $0.7 \mu\text{m}$. We must say that the definition of the NIR regime can be a bit tricky. We decided to include as a NIR spectroscopic observation those spectra obtained in the spectral range 7000 to $5 \mu\text{m}$. Thus, the NIR lower limit can include many *optical* papers, as the *I* and *Z* bands are accessible using CCD detectors or photographic plates.

From the bibliographic compilation we defined a number of *attributes* to be developed in a catalog that lists the NIR spectroscopic information for GOSC entries. The selected attributes are: BAND, SPECTRAL RESOLUTION, SPECTRAL BANDWIDTH, SCIENCE CLASS, FLUX, PLOT, DIGITAL DATA, EQUIVALENT WIDTH, RADIAL VELOCITY, WIDTH PROFILE. The SCIENCE CLASS attribute refers to the primary purpose for which the spectrum was obtained, i.e., to study the star itself, the ISM or the nebular surrounding.

The catalog will be published following Virtual Observatory standards in the GOSC web page: <http://ssg.iaa.es/en/content/gosc-v2-query/>

Figure 2 shows some examples of the information which can be extracted from the catalog.

At the moment, we have collected 663 different NIR spectroscopic observations of 166 GOSC stars from 62 papers so far reviewed. Some interesting results are already emerging. We find that radial-velocity and rotational broadening studies are very scarce in the NIR, as well as ISM studies beyond $1 \mu\text{m}$. Also,

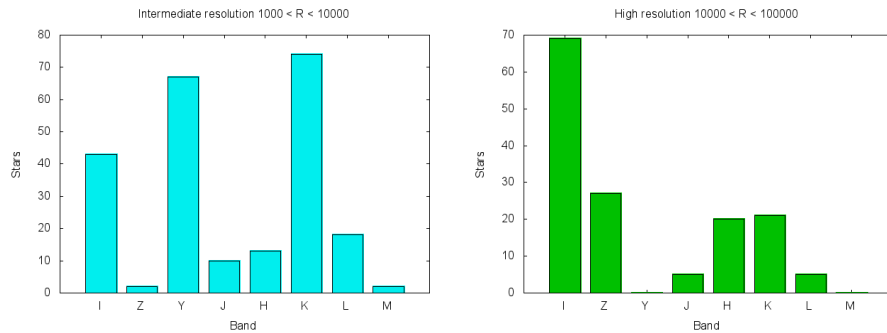


Figure 2. Number of stars observed in each NIR band at intermediate and high spectroscopic resolutions. The distributions clearly show how inhomogeneous is the knowledge of the O-type stars in the different spectral bands. This picture is even worst for specific spectral types, like O2, O3 or O6, which have never been observed at some resolutions. We note that there are only two observations of O-type stars at very-high spectral resolution ($R > 100000$) in the NIR.

most of the digital spectra available for researchers in astronomical databases come from just four papers.

Acknowledgments.

We wish to acknowledge to the referee, Dr. Margaret M. Hanson, for constructive comments and suggestions which helped to improve the paper. We thank financial support from DIULS PR09101, the *Facultad de Ciencias* ULS, and DGAE-ULS. This research has made use of NASA's Astrophysics Data System Bibliographic Services and SIMBAD database operated at CDS, Strasbourg, France.

References

- Andrillat, Y.& Houzieaux, L. 1967, *J. Obs.*, 50, 107
- Hanson, M.M. et al. 1996, *ApJS*, 107, 281
- Hanson, M.M. et al. 2005, *ApJS*, 161, 154
- Hewett, P. et al. 2006, *MNRAS*, 367, 454
- Lépine, J.R.D., Roman-López, A., Abraham, Z., Junqueira, T.C. and Mishurov, Yu.N. 2011, *MNRAS*, 414, 138
- Maíz Apellániz, J. et al. 2004, *ApJS*,
- Maíz Apellániz, J. et al. 2011, *Highlights in Spanish Astrophysics VI*, Proceedings of the IX Scientific Meeting of the Spanish Astronomical Society (SEA), held in Madrid, September 13 - 17, 2010, Eds.: M. R. Zapatero Osorio et al., 467
- Minniti, D. et al. 2010, *NewA*, 15, 433
- Sota, A. et al. 2008, *RMxAC*, 33, 56
- Sota, A. et al. 2011, *ApJS*, 193, 24